Solar Spectral Flux Radiometer, SSFR, in INTEX-B/MILAGRO:
Instrument Description and Science Goals

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Our primary objective is to support INTEX-B/MILAGRO by flying the Solar Spectral Flux Radiometer, SSFR, aboard the Jetstream-31 (J-31) to measure the spectrally resolved net solar irradiance in the Mexico City outflow region toward and over the Gulf of Mexico. These radiometric observations will be used to: quantify the solar spectral radiative energy budget; determine the solar spectral absorption in the atmospheric layers; relate our findings to the chemical and physical properties of aerosol; compare findings to other in situ and remote sensing methods of measuring absorption; quantify the effect of aerosols on cloud radiative properties (the “indirect effect”). The long-term goal of this research is to improve out knowledge of aerosol radiative processes and their influence on climate and to facilitate the remote sensing of aerosol radiative properties from space.

The Solar Spectral Flux Radiometer is a moderate resolution flux (irradiance) spectrometer.

- Wavelength range: 300 nm to 2200 nm
- Spectral resolution: ~ 8-12 nm
- Simultaneous zenith and nadir viewing
- Hemispheric field-of-view
- Accuracy: ~ 3%; Precision: 0.5%
- Measured quantities: Upwelling and down-welling spectral irradiance ($Wm^{-2}nm^{-1}$)
- Derived quantities: Spectral albedo, net flux, flux divergence (absorption), and fractional absorption
- Retrieved quantities: r_e, τ, liquid water path

The SSFR is a well-characterized sensor, having flown in several recent missions including the following: the Southern African Regional Science Initiative (SAFARI), 2000; the Cirrus Regional Study of Tropical Anvils and Cirrus Layers-Florida Area Cirrus Experiment (CRYSTAL-FACE), 2002; the ARM Aerosol IOP, 2003; and the International Consortium for

Atmospheric Research on Transport and Transformation (ICARTT) 2004. Among the many platforms that the SSFR has been integrated are the NASA ER-2, the NASA Altus II (UAV), the CIRPAS Twin Otter, the Scaled Composites Proteus, and the Sky Research J-31.

By deploying the Solar Spectral Flux Radiometer on the Jetstream-31 (J-31) to measure downwelling and upwelling solar spectral irradiance at multiple flight altitudes above and below aerosol layers and above cloud systems we want to achieve the following science goals:

- Column Closure Studies

  Measuring the spectrally and vertically resolved net solar irradiance will provide important constraints for column closure analysis to link aerosol radiative effects with their optical, microphysical and chemical properties. The vertically resolved net solar spectral irradiance will determine column solar radiative boundary conditions and, when combined with the aerosol spectral optical depth from the NASA Ames 14-Channel Airborne Tracking Sunphotometer (AATS-14), may be used in inversions procedures to provide aerosol absorption coefficient and single scattering albedo for thick polluted layers.

- Cloud Remote Sensing and Aerosol Indirect Radiative Forcing

  For J-31 flights over and beneath homogeneous cloud fields the SSFR spectral irradiance will be used to derive effective cloud droplet radius, optical depth, and liquid water path. When available we will compare with other aircraft cloud remote sensors and in situ sensors, with satellite cloud retrievals (for example, MODIS), and with surface sensors. We will examine the agreement between these retrieval methods as well as investigate the dependence of cloud morphology on the probability density distribution functions of retrieved cloud properties.

  The radiative influence of aerosol particles on clouds will be studied by examining the relationship between cloud droplet effective radius and aerosol extinction. Measurement of the vertical aerosol extinction from above cloud (AATS-14) and below cloud (surface lidar) will aid in this effort.

- Water-Leaving Irradiance: MISR Validation

  The purpose of this SSFR flight objective is to measure the water leaving radiance, or the ocean surface spectral albedo, to support validation of MISR low aerosol optical depth retrievals. The outgoing spectral radiance at the top of the atmosphere as seen from an Earth observing satellite is an integrated product of contributions from the surface and atmospheric column. MISR, for example, is sensitive to the spectral signature of radiation leaving the ocean surface and therefore typically uses only the red and near-infrared “dark water” bands for its aerosol retrievals. Ocean surface reflectance is assumed negligible in these bands in the current algorithm but it is not always negligible in the green and the blue, especially for low aerosol optical depth, and may not be negligible across the entire visible spectrum in shallow or polluted waters.

  The MISR team is developing an algorithm that uses multi-angle data to simultaneously retrieve surface reflectance and aerosol properties over shallow polluted waters. Even with a well-constrained atmospheric column, unless the surface contribution to top-of-atmosphere reflectance is known there remain significant uncertainties in the resulting retrieved aerosol properties and for low optical depth cases the sea surface albedo contributes the largest uncertainty.